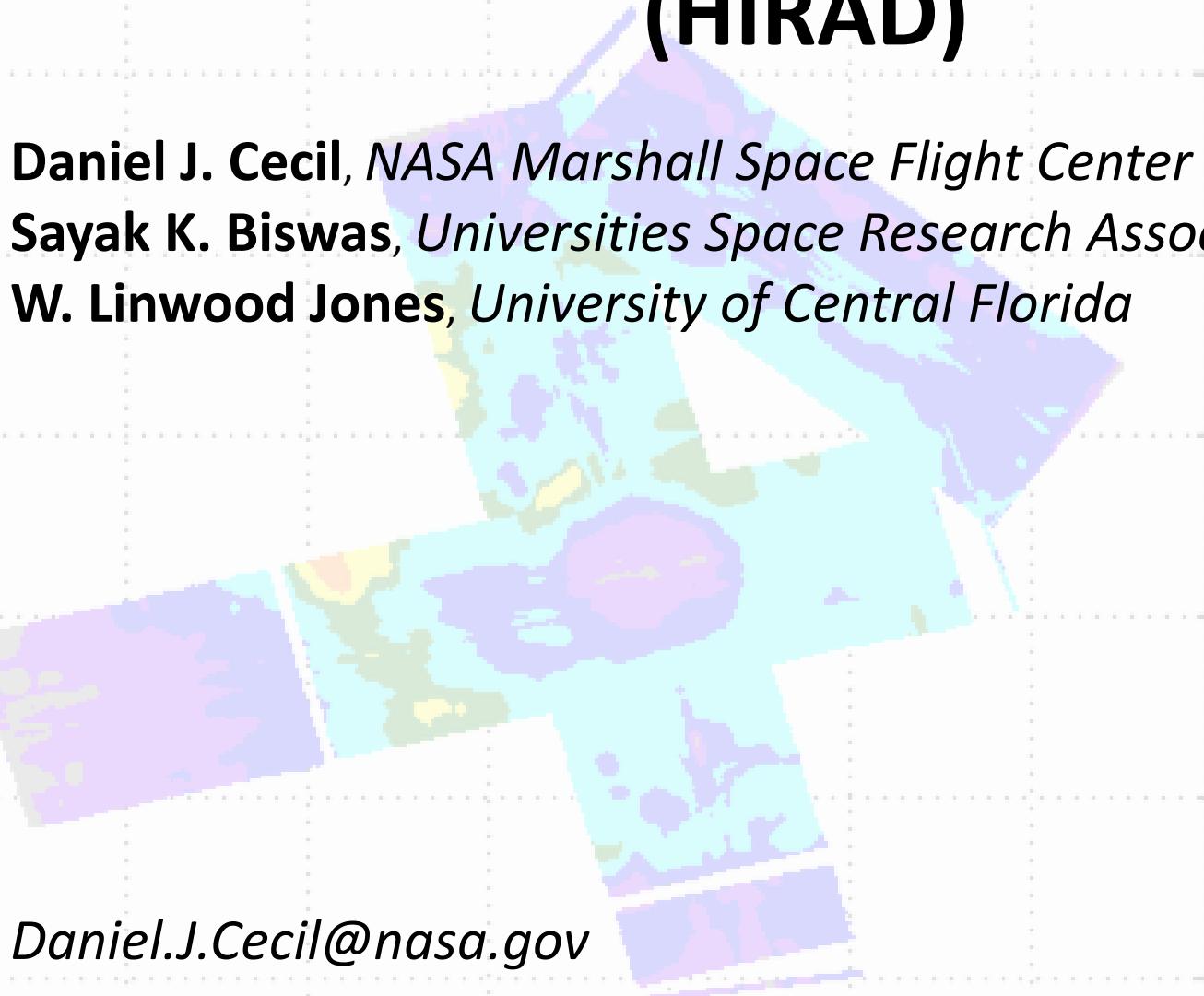


Hurricane Imaging Radiometer (HIRAD)

Daniel J. Cecil, *NASA Marshall Space Flight Center*

Sayak K. Biswas, *Universities Space Research Association*

W. Linwood Jones, *University of Central Florida*



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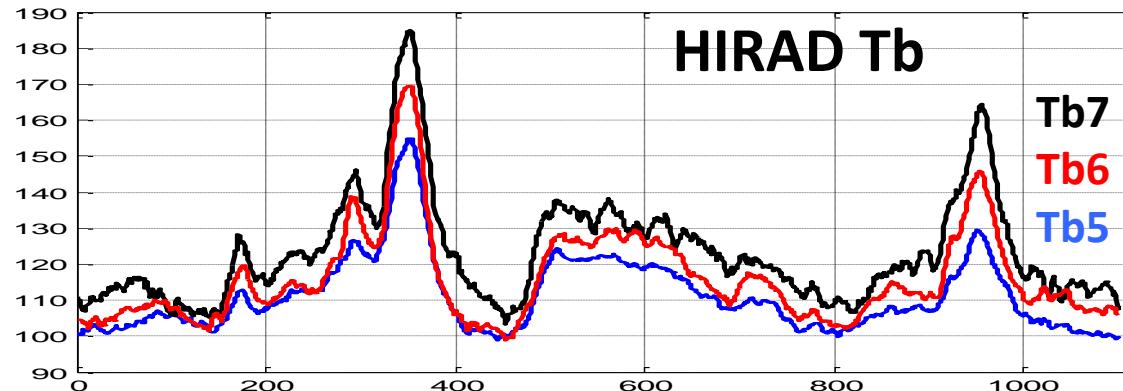
C-band (4, 5, 6, 6.6 GHz)
radiometer

Retrieval concept similar to
the operational Stepped
Frequency Microwave
Radiometer (SFMR)

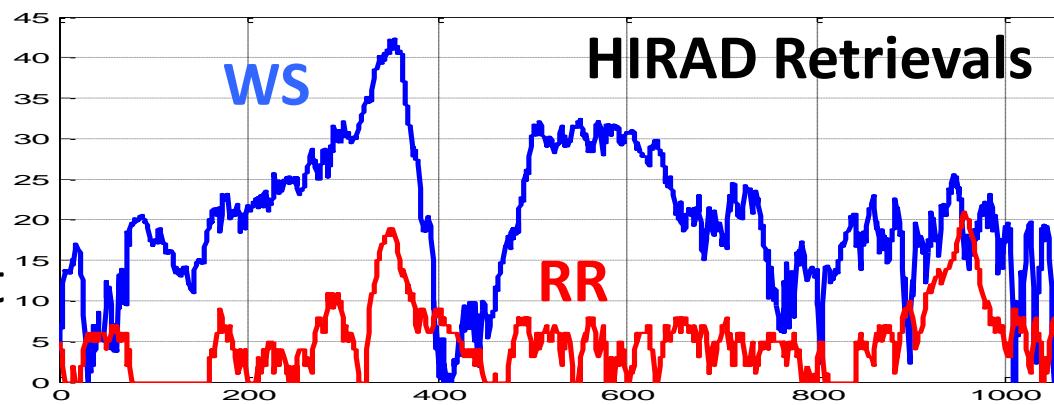
**Retrieve Wind Speed and
Rain Rate over ocean, *but
over a wide swath***

C-band frequencies have
varying sensitivity to rain but
~equal sensitivity to wind
speed (emission from foam
on wind-roughened ocean
surface)

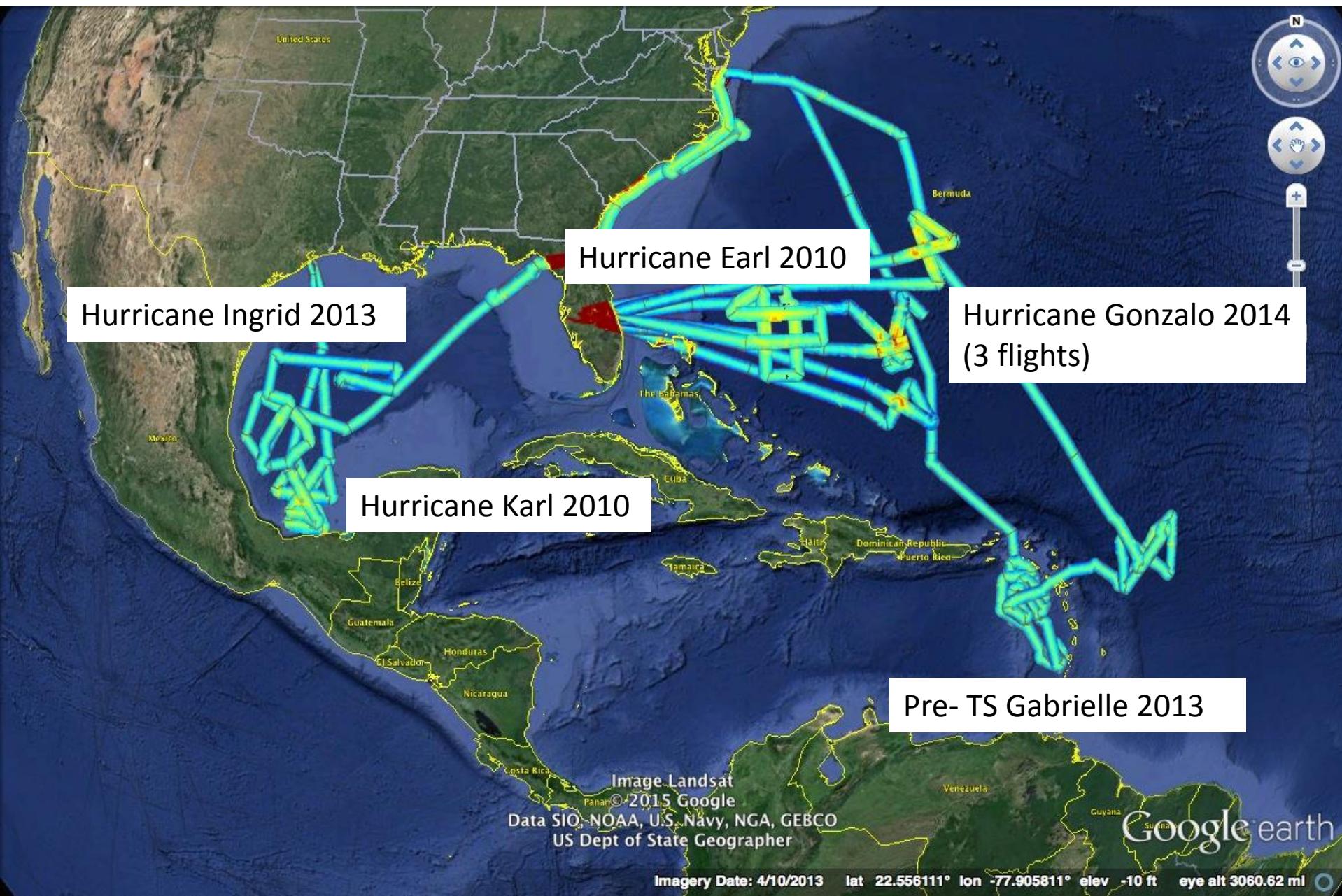
HIRAD Background



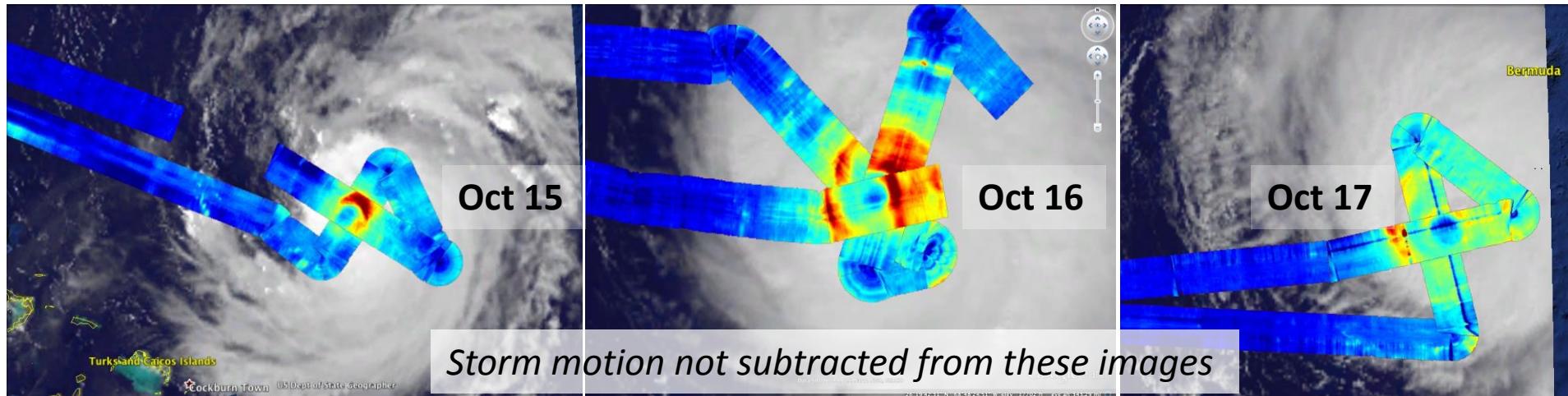
Hurricane Karl (2010) example



HIRAD Science Flights



Hurricane Gonzalo (2014)

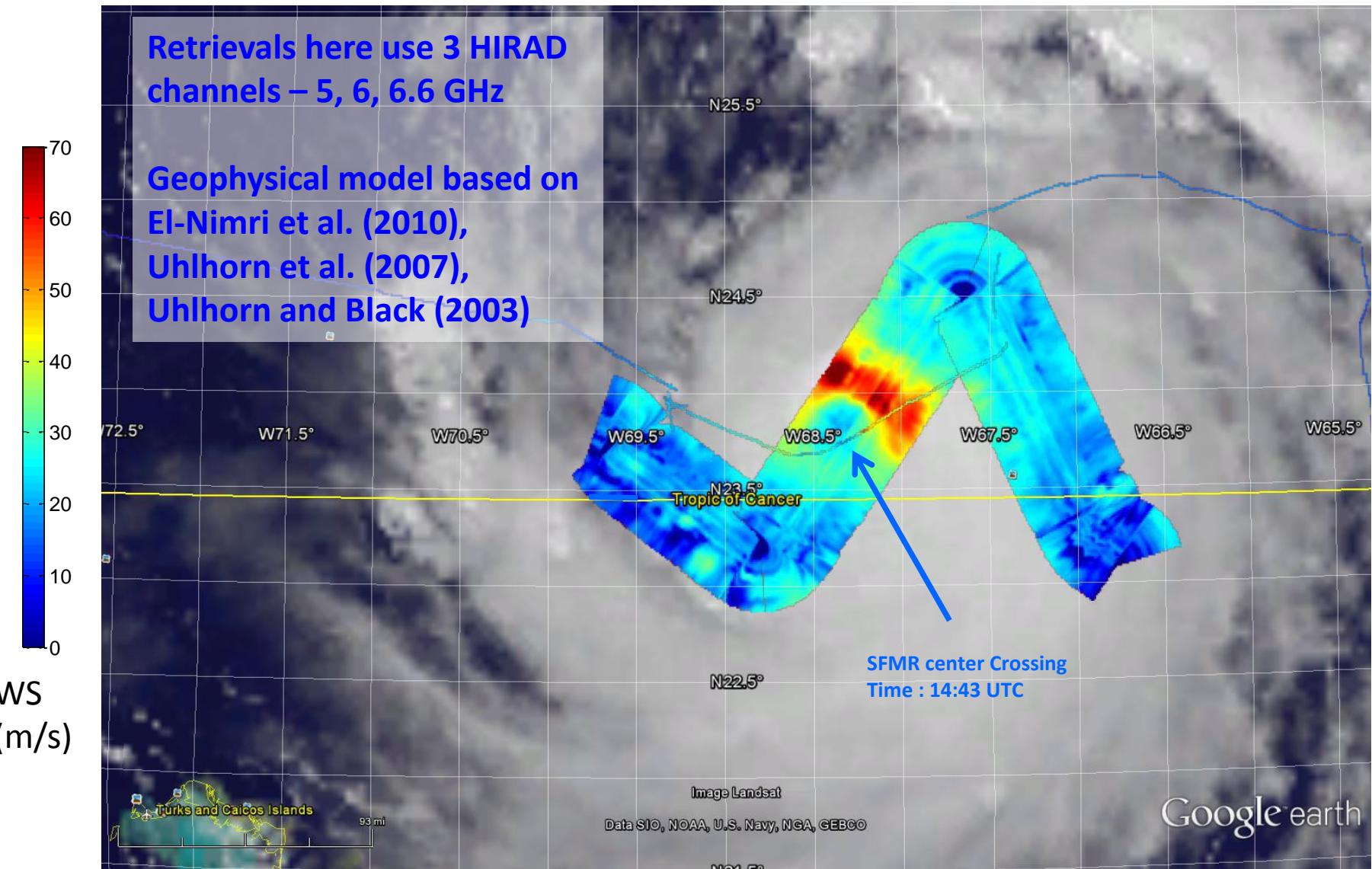


Flown on NASA WB-57 based out of Houston, forward-deployed to Tampa

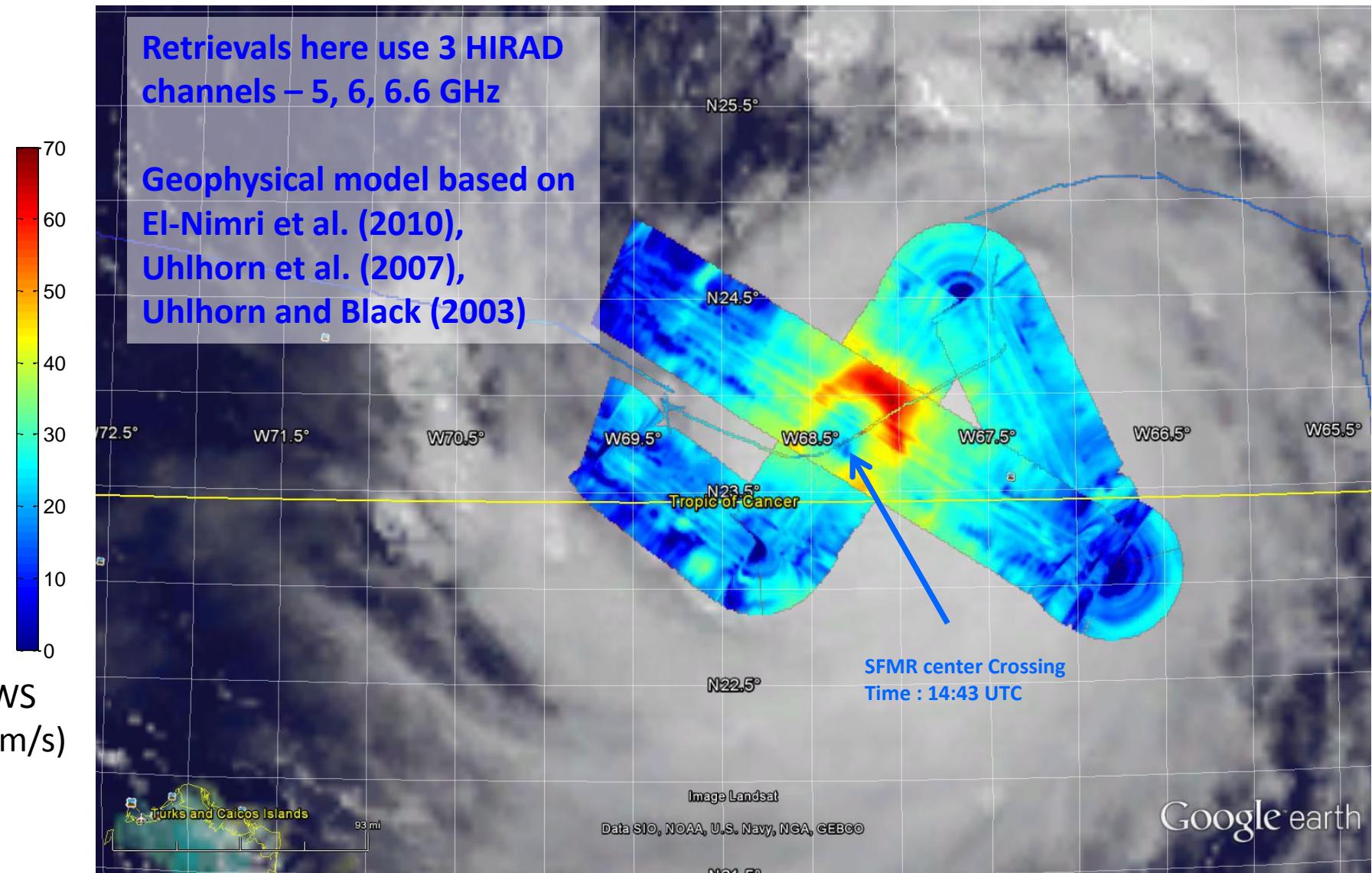
Cooperation between NASA HS3 program and ONR TCI program

Instruments were integrated onto Global Hawk AV-1 in July for HS3, but AV-1 was unable to perform missions. WB-57 was available for hurricane flights because of the ONR program, so HIRAD and HIWRAP were moved from Global Hawk to WB-57. Kudos to all who made this switch possible!

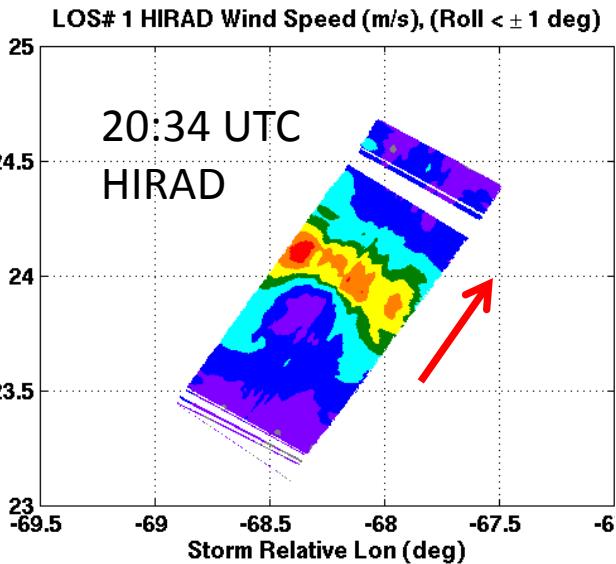
First Storm Center Crossing: 20:34 UTC



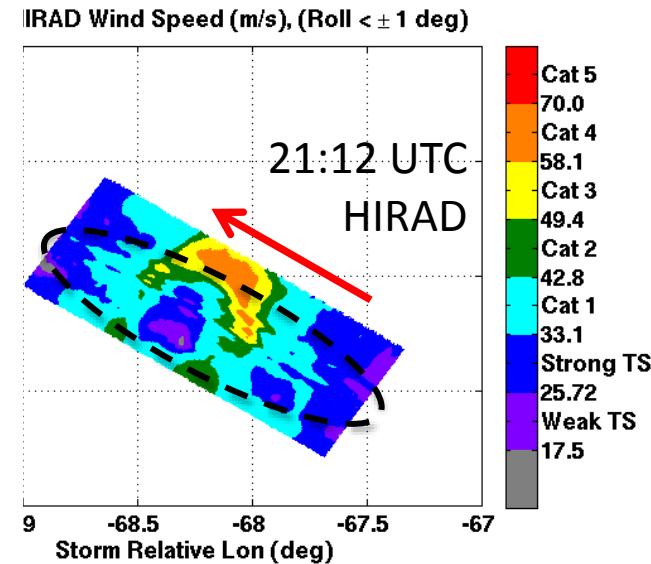
Second Storm Center Crossing: 21:12 UTC



Wind Retrievals – Oct 15 Gonzalo



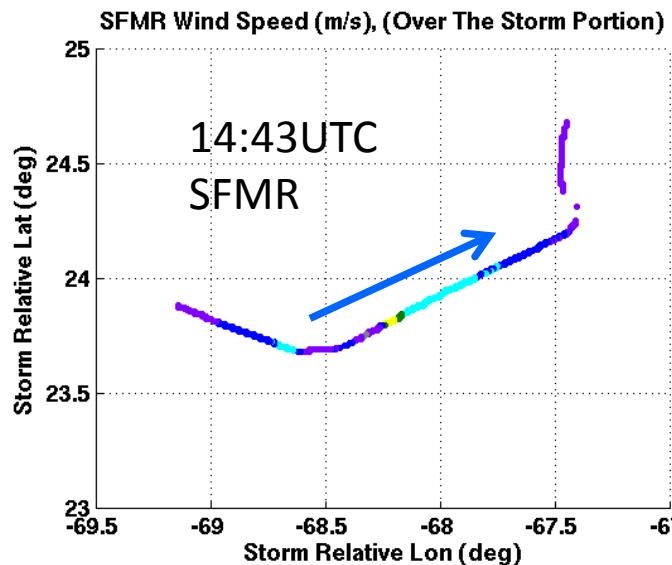
HIRAD has biases at some incidence angles, seen as along-track striping.



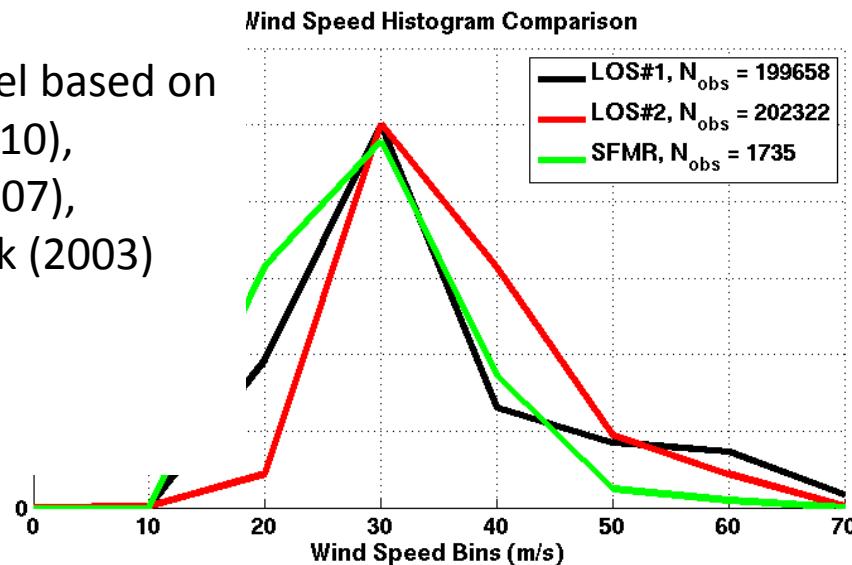
Also tends to be high-biased along left edge.

Work in progress

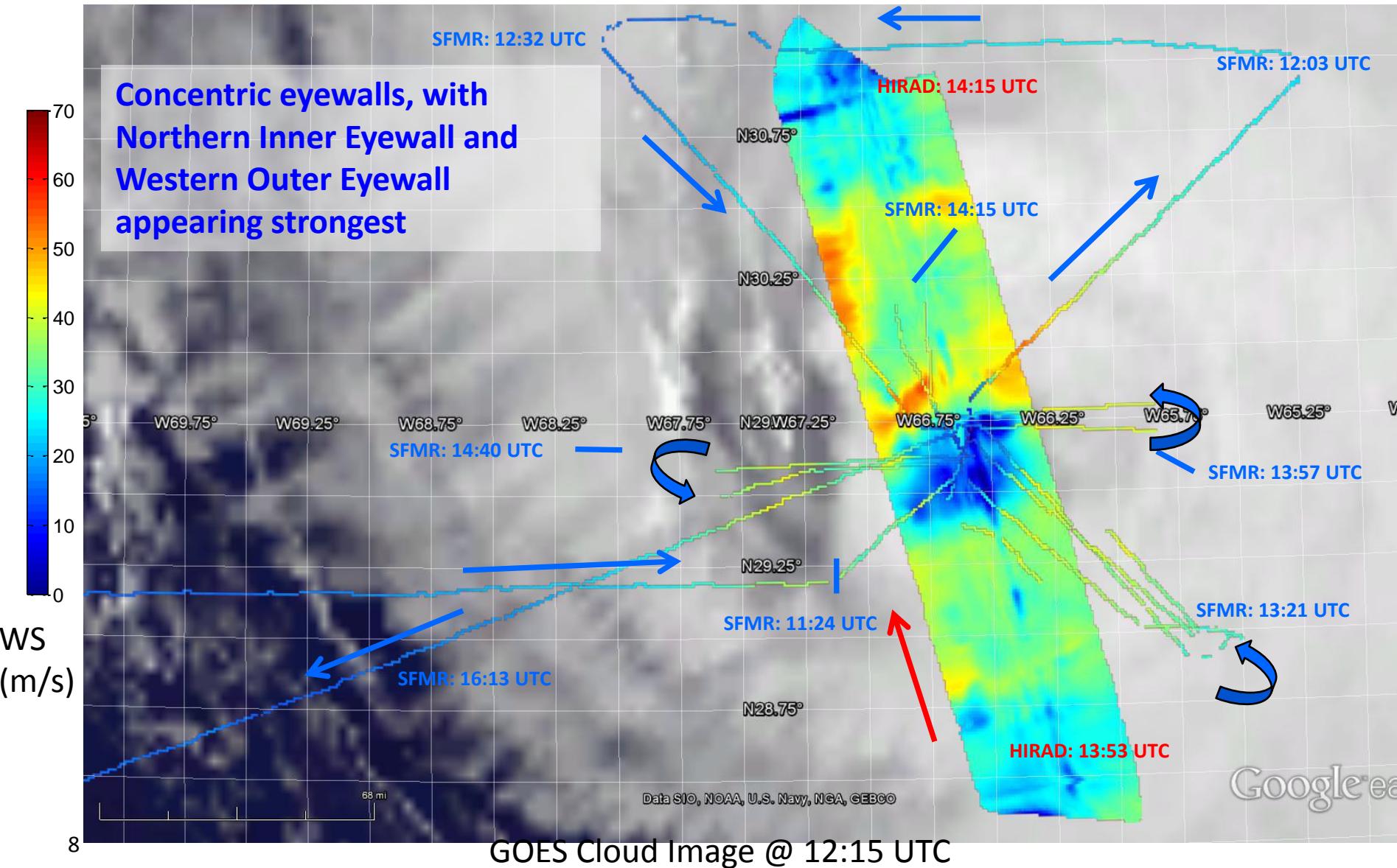
Retrievals here use 3 HIRAD channels – 5, 6, 6.6 GHz



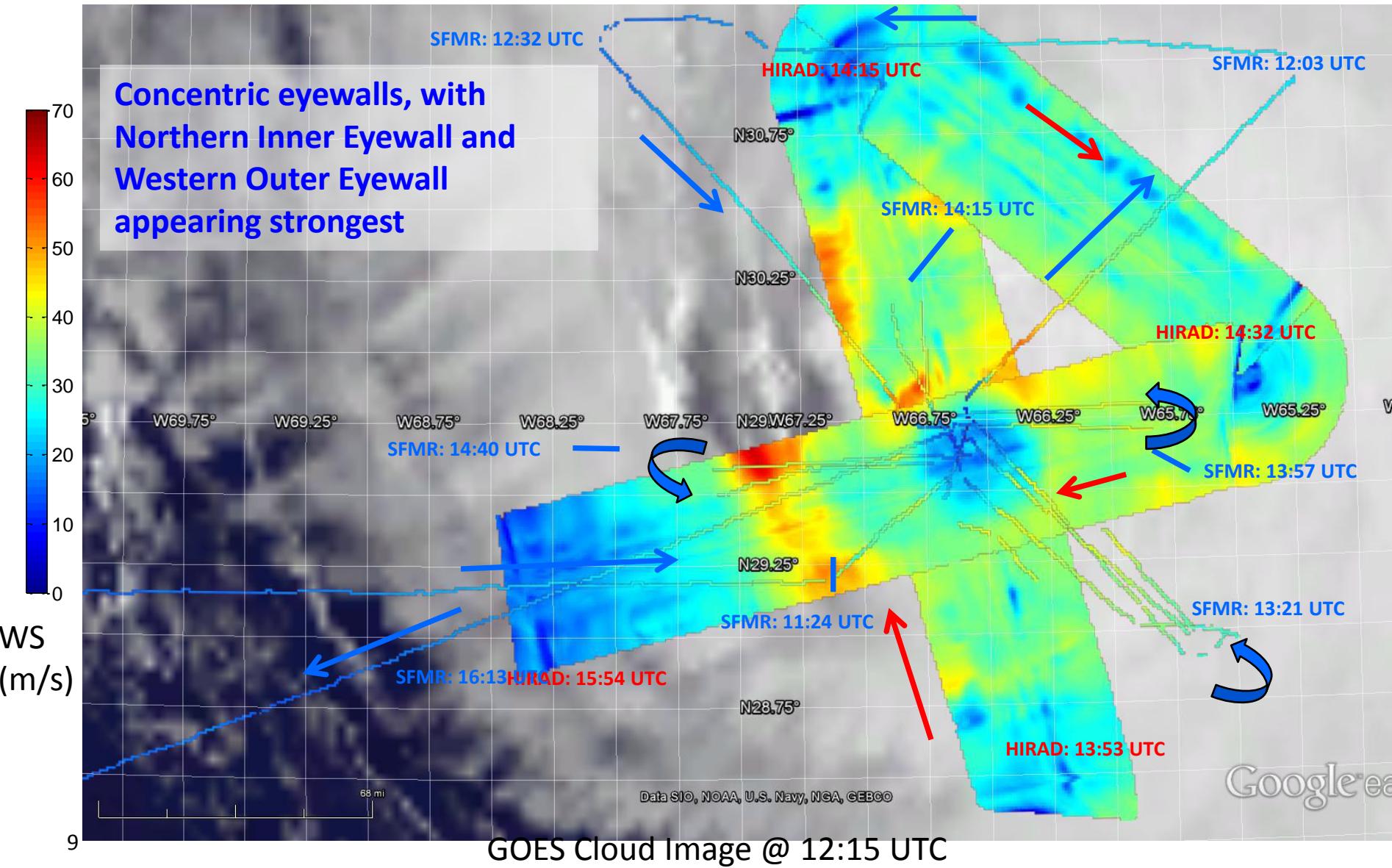
Geophysical model based on El-Nimri et al. (2010), Uhlhorn et al. (2007), Uhlhorn and Black (2003)



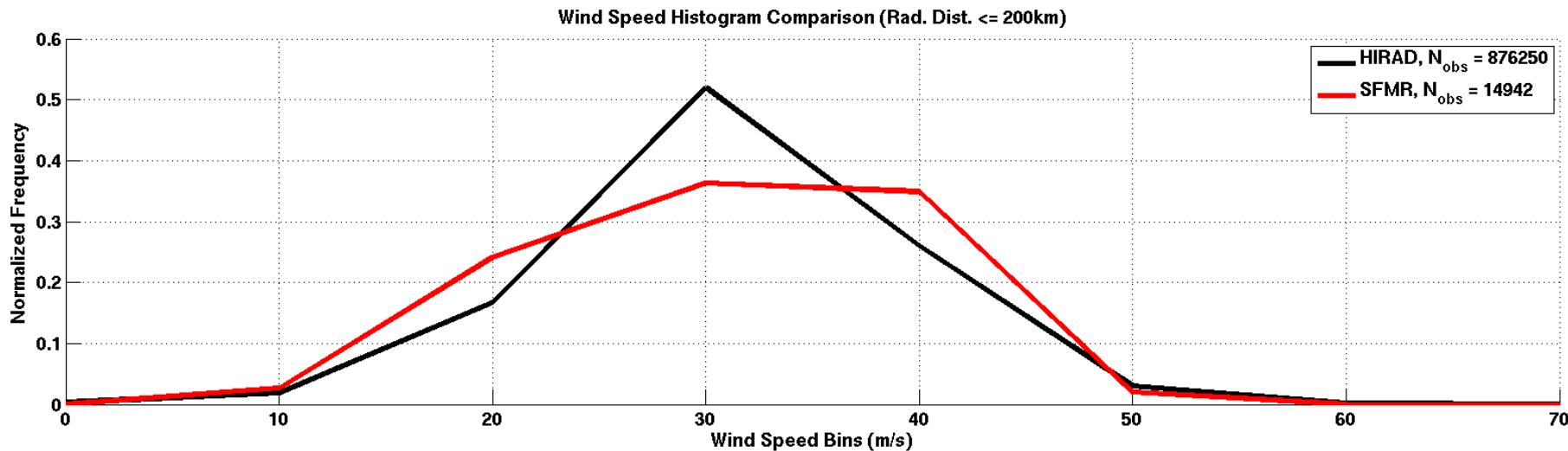
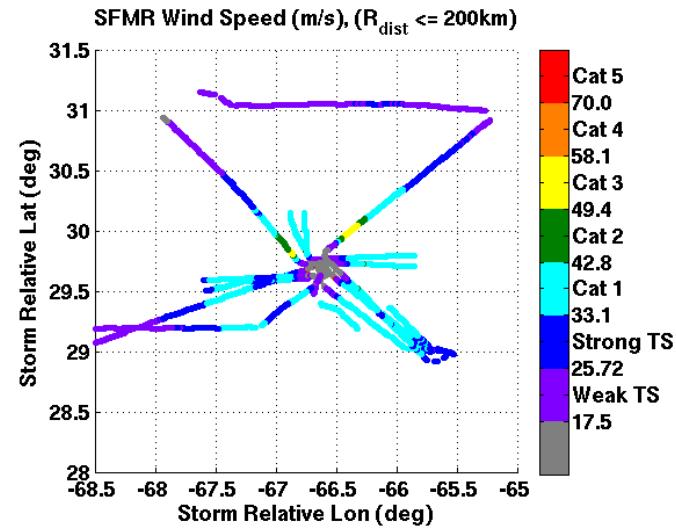
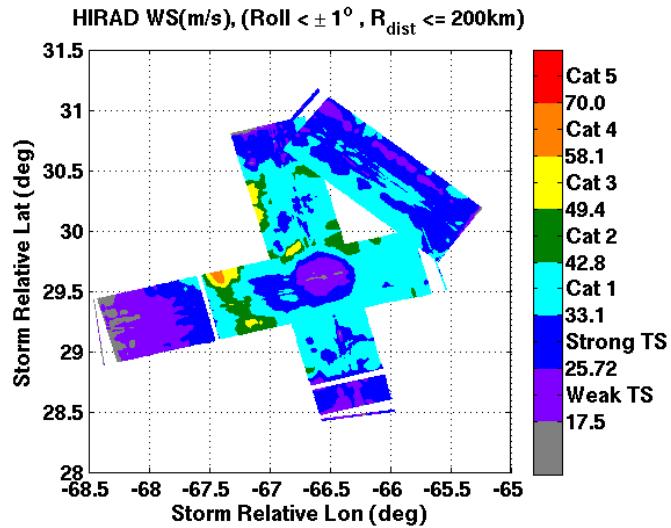
First Storm Center Crossing: 14:04 UTC



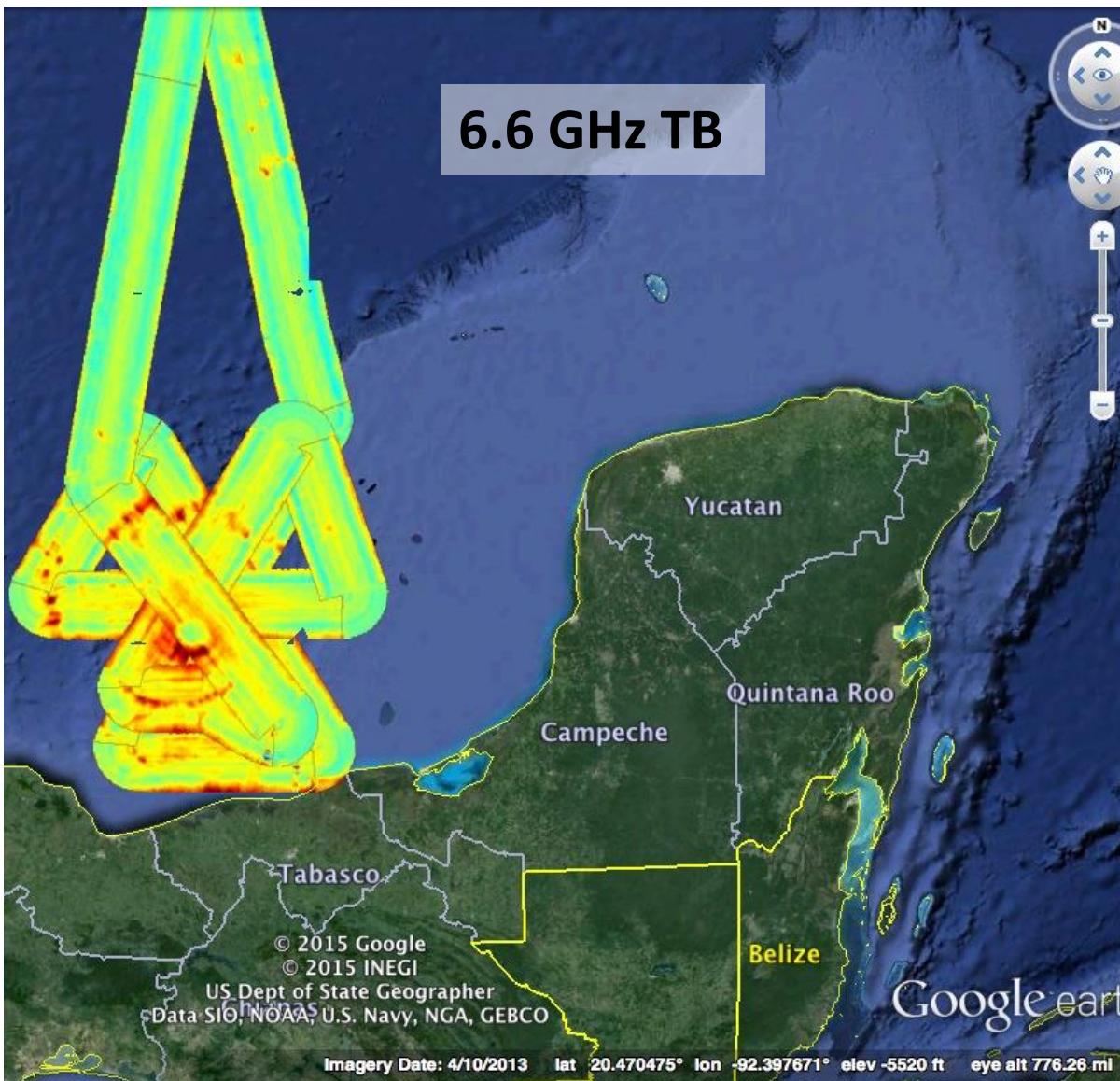
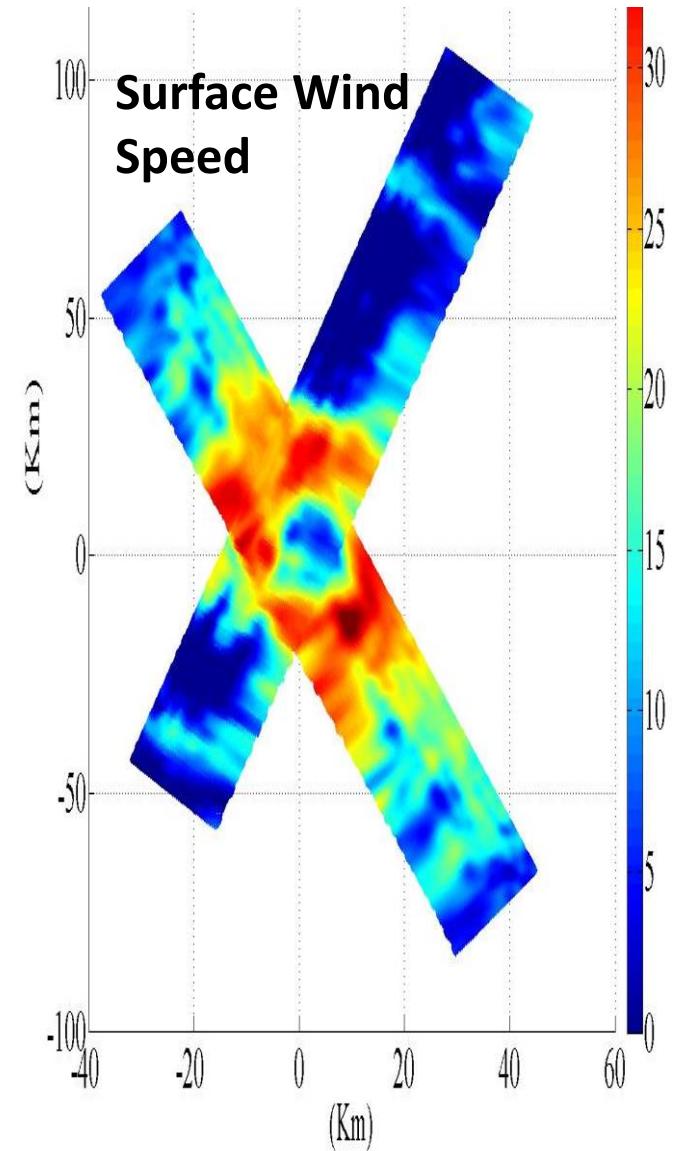
Second Storm Center Crossing: 14:41 UTC



Wind Retrievals – Oct 17 Gonzalo



Hurricane Karl (2010) Brightness Temp and Wind Speed Retrieval



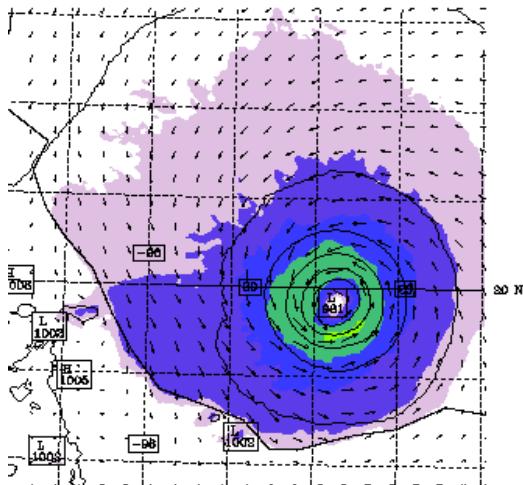
HIRAD Wind Retrieval, Assimilation for Hurricane Karl

Surface wind field in data assimilation experiments from Jason Sippel at GSFC

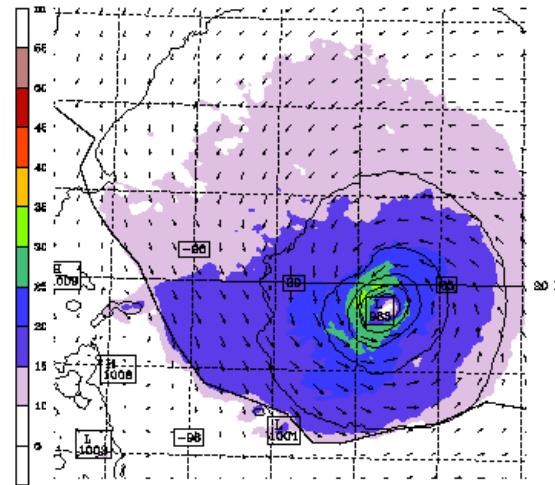
Adding HIRAD (bottom middle) improves characterization of asymmetric nature of wind field, and correctly reduces the horizontal extent of the wind field. Control and Control+HIWRAP(radar) experiments had Radii of 50-kt and 34-kt winds too large, compared to Best Track

Best results from assimilating Dropsonde, HIRAD, HIWRAP together

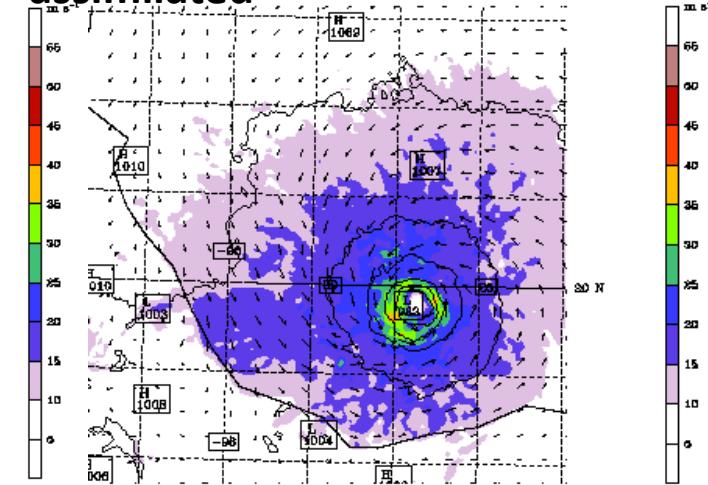
**HIWRAP VAD wind
assimilated**



**HIRAD surface wind
and HIWRAP VAD wind
assimilated**



**HIRAD surface wind, dropsonde
wind, and HIWRAP VAD wind
assimilated**



Summary

- 3 Science Flights from WB-57 over Hurricane Gonzalo (2014)
- Wide-swath data helps paint a picture of hurricane structure
- Initial retrievals from Oct 15, Oct 17 flights look good, some systematic (scan-angle dependent) biases remaining
- Oct 16 data needs more cleanup before retrievals, but hurricane structure is there
- Hurricane Karl (2010) wind retrievals tested in assimilation with dropsondes and HIWRAP; improved structure of wind radii

